Weights are tied to each end of a 20.0cm string. You hold one weight in your hand and let the other hang vertically a height h above the floor. When you release the weight in your hand, the two weights strike the ground one after the other with audible thuds. Find the value of h for which the time between release and the first thud is equal to the time between the first thud and the second thud

Solution:

The tension in the string will be zero during the descent because each ball accelerates at the same rate. Therefore the string will have no effect upon the motion of the balls.
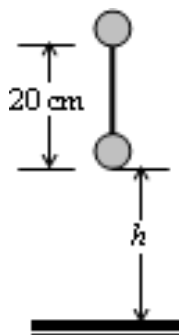
The problem requires that the time to fall a distance h from rest (the time between release and the first thud) is the time to fall a distance h + 20 cm (second thud) minus the time to fall a distance h (first thud). We can set these times equal to each other.

$$t_h = t_{h+20} - t_h$$
$$2t_h = t_{h+20}$$

The time to fall from h is

$$t = \sqrt{\frac{2h}{g}}$$

Thus,

$$2\sqrt{\frac{2h}{g}} = \sqrt{\frac{2(h + 20 \text{ cm})}{g}}$$

Square both sides and multiply by g / 2:

$$4h = h + 20 \text{ cm}$$
$$h = \frac{20}{3} = 6.67 \text{ cm}$$

Answer: $h = 6.67$ cm